Analysis of Selected Biomechanical Parameters in National and International Race Walkers of India

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CHAPTER - I

INTRODUCTION

Man is a living organism that has inherited not only a systematic structure but also, motor behavior patterns. With the understanding of these patterns, we can classify each motor act; identify the basic similarities and variations that occur in a specific situation. To achieve this, we must use information from other fields i.e., from physics/mechanics explanations for operating forces; from anatomy and neuromuscular physiology explanation for joint actions. The human body is a very complex system that is subject to both mechanical and biological laws and principles. How effectively and efficiently it performs, depends upon both its mechanical and biological aspects and functions as they are directly related to physical performance.

Sports and physical activity have been considered an integral part of human life since its inception. It is universally accepted that sports and games fulfill the requirements of human activities. The athletes of today, whether recreational or elite, run and swim faster, throw farther, and jump higher than their competitors from the past. These improvements have been attributed to several factors related to smarter nutrition; a greater understanding of the biomechanics of sport movement, better training techniques, advances in psychological support, and improvements in coaching education. Continuing efforts to extend laboratory research into the sport-specific field setting have resulted in the identification of several variables deemed necessary for successful performance in several sports. The adoption of this marriage of 'science and sweat' has been slow for a variety of reasons. Typically, sports performance testing has been expensive and limited to facilities at the elite levels of sport, generally out of the general public's reach and the everyday coach's budget. However, because of a greater focus on the prevention of injuries and on enhancing

performance at the younger levels of play, the opportunity to combine cutting-edge sports science technology with the traditional field and court assessment has never been easier and is much more readily accessible to today's progressive thinking coach.

Human movement performance can be enhanced in many ways. Effective movement involves anatomical factors, neuromuscular skills, physiological capacities, and psychological / Cognitive abilities. Most kinesiology professionals prescribe technique changes and give instructions that allow a person to improve performance. Biomechanics is most useful in improving performance in sports or activities where technique is the dominant factor rather than the physical structure or physiological capacity.

Biomechanics is an applied form of mechanics and consequently, the method used to investigate, it must be derived from those of mechanics. When the study of mechanics is limited to living structures, especially the human body, it is called biomechanics. Biomechanics is an interdisciplinary science based on many of the fundamental disciplines found in the physical and life sciences. Generally, biomechanics is considered to be that aspect of the science concerned with the basic law governing the effect forces have on the state of rest or motion of animals or humans, whereas the applied areas of biomechanics deal with solving practical problems. Anatomists, orthopedists, space engineers, industrial engineers, biomedical engineers, physical therapists, physical educators, dancers, and coaches all have an interest in this. Biomechanics and applying its principles to the improvement of human movement. Professional applications may differ, but the same basic laws of biomechanics provide a common foundation for all.

Biomechanical or movement analysis is often thought of as just that- the process of observing (measuring) the performance of a skill, identifying faults in the

performance, and providing feedback to the performer to help correct those faults. Indeed, these steps are part of a biomechanical analysis.

Physical educators teach a wide variety of human movements, and biomechanics provides a rationale critical for evaluating techniques and prescribing interventions to help young people improve. Biomechanics also allows physical educators to identify exercises and physical activities that contribute to the physical development of various muscle groups and fitness components. Real movement performances and typical teaching cues are used to show how biomechanics is applied to real-world physical education.

The analysis involves breaking something into smaller parts and then examining those parts. Biomechanics research at the practical, fundamental, and theoretical levels has increased markedly in recent years. As this work becomes more complex and sophisticated, it is necessary for researchers to improve their instrumentation systems, experimental procedures, data recording, analysis methods, and means of disseminating their findings. The ultimate success of biomechanics research will depend greatly upon the creativity and competence of the researchers in their continual efforts to strive for more effective means of investigating human movement.

In performing a mechanical analysis of a motor skill, the human body is often viewed as a machine. Subject to the same laws and mechanical principles that govern the actions of any other machine, the mechanical analysis of human performance involves the identification of laws and principles that help explain the most appropriate form for the execution of the activity and identify the mechanical reasons for success or failure. To assess the mechanical nature of a technique and use this information in helping performers choose movements that will result in skillful motion, the analyzer should attempt to identify those principles and laws that verify

the actions as desirable. Once the movement is classified according to an outline such as that on, the analyst should determine exactly how and when the movement of the performance does or does not satisfy the standard of good performance as explained by the laws and principles of mechanics. Once this process is accomplished, a greater depth of understanding of the skill is achieved, and the basis for making change is founded on sound knowledge and understanding of the reason.

There are basically two methods by which motor skills can be analyzed the qualitative method and the quantitative method. With the qualitative method, the performance is evaluated subjectively. With the quantitative method, the performance is first recorded using photography, cinematography, electromyography, or some other recording technique and is then evaluated objectively based on measurements taken from the records.

The quantitative method is used extensively by researchers, occasionally by coaches, and only very rarely by physical education teachers. Researchers use the quantitative method for a wide variety of purposes. It is used, to identify the factors that determine success in the performance of a motor skill. Thus, in a study of sprinting, a researcher might take a high-speed motion picture films and analyzes these frames by frame to determine such quantities as the horizontals and vertical velocities of the center of gravity at critical instants through the sequence of motion at the instants of touchdown and takeoff for each ground support phase, for example. On the basis of these measures and, usually, some form of statistical analysis, the researcher would then reach conclusions concerning the factors that determine success.

Analysis in both quantitative and qualitative contexts means identification of the factors that affect human movement performance, which is then interpreted using other higher levels of thinking (synthesis, evaluation) in applying the information to the movement of interest. Solving problems in human movement involves high

levels of critical thinking and an interdisciplinary approach, integrating the many kinesiology sciences.

Modern video cameras are now able to deliver excellent picture quality (although still not quite as good as Cine) and high-speed models can achieve frame rates at least comparable to high-speed Cine cameras. Unlike cine film, most video recording involves no processing time and the recorded images are available for immediate playback and analysis. Videotapes are very inexpensive when compared to the high cost of purchasing and processing cine film. The significant improvements made in video camera technology, coupled with a substantial fall in the price of the hardware over the past decade, have led to cine cameras becoming virtually redundant in sport and exercise biomechanics. Video recordings of sports and exercise activities are usually made by biomechanists in order to undertake a detailed analysis of an individual's movement patterns.

Videography is the process of capturing images on a videotape or directly to a computer, also used to include the later analysis of these images. A great strength of videography is that it enables the investigator to record sports movements not only in a controlled laboratory setting but also in competition. It also minimizes any possible interference with the performer. Video analysis is the process of filming human movement, importing the footage to a computer, and then analyzing performance using custom-designed computer software Programs. There are two categories of video analysis software: skill analysis and match analysis.

While most track and field events largely culminate into feats that need bursts of energy to perform, race walking stands out as a sport that priority precision and discipline. Although it may look easy, race walking, an Olympic sport, is in reality very difficult.

Race walking is believed to have originated in the Victorian era (1837-1901) when noblemen used to bet on their footmen -- who walked alongside their employer's horse-driven coaches -- for a winner. It came to be known as pedestrianism and made its way to the United States in the late 19th century.

Race walking is a long-distance footrace in which the athletes must walk and not run. In race walking, there is a rule known as the "straight leg rule," which means the moment the leading foot touches the ground and until the leg passes under the center of the body, the knee is not allowed to bend. Athletes are penalized for bending their knees, as their knee passes under the body or when one of their feet is not touching the ground, which is why form and technique are very important in this sport.

Race walking can be dated back to about 400 years ago in England. It did not take long to become a very popular sport throughout the world. By the 19th century, racewalking was just as popular as horse racing. Race walking and horse racing had one thing in common, which was betting. What made these races interesting to place bets on is that racers would suffer through races that would last for several days. The typical races at this time would consist of racers trying to walk 100 miles in less than 24 hours. Other racers would last more than 40 days, where the racers would try to walk one mile each hour. It did not take long afterward for race walking to become a part of the Olympics. In 1908, race walking was an Olympic game for men, and it took 84 more years for women to be able to participate in Olympic race walking. Some most memorable race walkers in history are Ken Matthews, who won the 20-kilometer event in the 1960 Olympics, and Don Thompson who won the 1964 Olympic race walking for the 50-kilometer race

Rules of race walker: The name of the sport itself defines the objective where participants swiftly walk their way to the finish line. However, it is bound by strict rules pertaining to its technique.

Race walking differs from running, where an athlete often has both feet off the ground during their strides in a sprint. In race walking, however, athletes must always have one foot in contact with the ground at all times, as visible to the human eye. Judges are present at events to ensure the rule is enforced. If there is no visible contact, it is deemed as 'lifting' and attracts a penalty.

Furthermore, the athlete's knee of their advanced leg must not bend and the leg must straighten as the body passes over it. Each racewalker is judged carefully and can be penalized if he bends his knee during the race.

Judges ranging from five to nine, depending on the category of the event, inspect the race with their naked eyes. They carry paddles with symbols for 'loss of contact' (~) and 'bent knee' (<).

If a race walker is shown three warnings (paddles) from different judges, including the chief judge, it leads to the disqualification of the athlete. A red paddle is shown to the disqualified athlete.

The standard distances for race walking events are 3000m, and 5000m in indoor tournaments while 5000m, 10,000m, 20,000m, and 50,000m races are held on outdoor tracks. The 10km, 20km, and 50km events, labeled separately, are held on metaled roads.

Race walking is still emerging as a global sport in India and India has started producing some good race walkers at national and international platforms but still, it needs to work a lot to find a place in the medal tally at the Olympics. I come from

a small town Gopeshwar of Uttarakhand which has gained the attention of many for producing Olympians and many national and international race walkers…I have witnessed them very closely and feel that little more scientific assistance given to them by analyzing various biomechanical factors, better performance can be predicted. Very little work has been done with race walking in the Indian context and this is the reason why I have chosen this area to work on.

STATEMENT OF THE PROBLEM

The purpose of the study is three-fold: first, to compare the selected biomechanical parameters between national and international race walkers of 20 km race walk event; second, to find out the relationship of selected biomechanical parameters with race walking performance of 20 km race walk event; and third, to predict the race-walking performance with the help of selected biomechanical parameters.

OBJECTIVES

The following are the objectives of the study:

1. To compare the selected biomechanical parameters between national and international race walkers of the 20 km event.
2. To analyze the relationship of selected biomechanical parameters with race walking performance of a 20 km race walk event.
3. To analyze the relationship of selected biomechanical parameters with the average speed of walking in 20 km race walkers.
4. To analyze the relationship of selected biomechanical parameters with the Height of the Centre of Mass during different phases of walking in 20 km race walkers.

5. To analyze the relationship of selected biomechanical parameters with the Symmetry Index of walk in 20 km race walkers.
6. To predict the race-walking performance based on selected biomechanical parameters.

DELIMITATIONS

The study will be delimited to the following:

1. A total of 20 male race walkers of the 20 km event will be selected as subjects for the study. Out of 20 subjects 10 subjects are to be taken from national level and 10 from international level.
2. Race walkers who had participated national level and international level will be considered as subjects for the study.
3. The study will be delimited to selected angular kinematic variables:
    - Right & left elbow joint
    - Right & left shoulder joint
    - Right and left hip joint
    - Right & left knee joint
    - Right & left ankle joint
4. The study will be further delimited to the following linear kinematic variables:
    - Stride length
    - Cadence
    - Stance phase duration
    - Average Speed
    - Symmetry Index

- Height of Center of Mass at the single support phase, double support phase, and swing phase.

HYPOTHESIS

1. It is hypothesized that there will be a significant difference in selected biomechanical parameters between national and international race walkers of the 20 km event.

2. It is hypothesized that there will be a significant relationship between selected biomechanical parameters with the race-walking performance of the 20 km race walk event.

3. It is hypothesized that there will be a significant relationship between selected biomechanical parameters with the average speed of walking in 20 km race walkers.
4. It is hypothesized that there will be a significant relationship between selected biomechanical parameters with the Height of the Centre of Mass during different phases of walk in 20 km race walkers.
5. It is hypothesized that there will be a significant relationship between selected biomechanical parameters with the Symmetry Index of walk in 20 km race walkers.

6. It is hypothesized that selected biomechanical parameters will significantly contribute to predicting race walking performance.

DEFINITION AND EXPLANATION OF THE TERMS

Biomechanics:

Biomechanics is the science concerned with the internal and external forces acting on a human body and the effects produced by these forces**.** (Hay, 1993)

Kinematics:

Kinematics is that branch of biomechanics which is concerned with describing the motion of bodies. Thus, kinematics deals with such things as how far a body moves, how fast it moves, and how consistently it moves. It is not concerned at all with what causes a body to move the way it does. (Hall, 1995)

Center of Gravity:

The center of gravity of any object is that point at which all the weight of an object may be considered to be concentrated (Charles E, 1960).

Stride Length:

Stride length is the distance covered by one stride. It was measured from the head of the rare foot up to the toe of the front foot and was expressed in meter units.

Support time:

Support time was considered as the time for which one foot-maintained contact with the ground. The support phase began with the plantation of a foot ahead of the body's center of gravity. From this point up to the stage when the center of gravity comes vertically upward over the foot was considered as the front support time. From this position up to the time of complete lifting of the foot from the ground was considered as the backward support time.

Time for the swing phase:

The swing phase was the non-conduct phase for a foot during walking. It started with lifting the foot from the ground continued through carrying the foot forward direction and ended with the touching of the foot to the ground.

Cadence:

It is defined as the number of steps per minute.

G-sensor:

The G-Sensor is an innovative device, which can be used for gait analysis. It uses a unique method to generate spatial-temporal parameters as well as pelvic kinematics during gait. It is a small, easy-to-use, and extremely portable device. The system works by using a tri-axial accelerometer, a magnetic sensor, a tri-axial gyroscope and a temperature sensor.

SIGNIFICANCE OF THE STUDY

The modern age of sports is the age of Excellency, so in every sport perfection and purification of skill has got its immense importance, and research in the field has allowed for excelling performance. The results of this study may be useful to physical education teachers, coaches, research scholars, and students in the following ways;

- The finding of the present study may have a significant contribution towards the refinement of race-walking technique.
- This study may be helpful to physical education teachers, coaches, and athletes to evaluate the race-walking technique and performance.

- The study may also help the students having sports biomechanics as a subject to understand the science of race-walking movement in a better manner.
- The study may provide knowledge to the students about the procedure related to the analysis of various angles to be found out in race walking movement.
- The finding of the study may also help coaches to rectify technical errors while teaching race walking.
- This study may provide a basic concept for the technique of race walking.
- The present study may educate the coaches regarding the role played by these variables in achieving high performance.

CHAPTER II

REVIEWS OF RELATED LITERATURE

Hanley, Brian (2013) conducted a study on biomechanical analysis of world-class senior and junior race walkers. The purpose of this study was to conduct a biomechanical analysis of all 15 medalists at the 25th IAAF World Race Walking Cup in Saransk, Russia. Each of the medalists was videoed during the faster second half of the race. Two cameras were placed alongside the course and a 3D analysis of the video data was conducted in order to measure the most important variables in race walking. As expected, stride length correlated with velocity, and data on individual athletes emphasized the importance of this variable. However, longer strides were negatively associated with stride frequency, so a balance between these two fundamental variables is advisable. The athletes adhered very closely to the race-walking rule regarding having a straightened knee at first contact; however, they were closer to the threshold of visibly losing contact. While there was little variation between athletes in terms of hip and knee angles, there were larger variations found within the measurements of shoulder and elbow angles. Coaches and athletes should be mindful that race walking is a whole-body activity and inefficient movements should be identified and corrected as appropriate.

Hanley, Brian, and Bissas, Athanassios (2013) worked on the analysis of lower limb internal kinetics and electromyography in elite race walking. The aim of this study was to analyze lower limb joint moments, powers, and electromyography patterns in elite race walking. Twenty international male and female racewalkers performed at their competitive pace in a laboratory setting. The collection of ground reaction forces (1000 Hz) was synchronized with two-dimensional high-speed videography (100 Hz) and electromyography of seven lower limb muscles (1000 Hz). As well as measuring key performance variables such as speed and stride length, normalized joint moments and powers were calculated. The rule in race walking which requires the knee to be extended from initial contact to mid-stance effectively made the knee redundant during stance about energy generation. Instead,

the leg functioned as a rigid lever which affected the role of the hip and ankle joints. The main contributors to energy generation were the hip extensors during late swing and early stance, and the ankle plantar flexors during late stance. The restricted functioning of the knee during stance meant that the importance of the swing leg in contributing to forward momentum was increased. The knee flexors underwent a phase of great energy absorption during the swing phase and this could increase the risk of injury to the hamstring muscles.

Hanley, Brian, et al. (2014) analyzed the angular kinematics in elite race-walking performance. The purpose of this study was to measure and analyze the important angular kinematic variables in elite race walking. Research has shown that these variables include knee angle at contact and mid-stance, rotation of the hips and shoulders, and hip extension velocity. Eighty elite race walkers were videoed during the competition and analyzed using 3D-DLT with SIMI Motion. The knee angle was found to be almost straight at contact in most athletes and hyperextended by the vertical upright position. Athletes varied in the amount of rotation at the hips and shoulders, with 50 km men having greater hip rotation and 20 km women having greater shoulder rotation. There was much more variation in the values found for elbow and shoulder angles. Very few angular measurements correlated with key race-walking variables such as speed, step length, and cadence.

Hanley, Brian, et al. (2010) conducted a study on biomechanical analysis of elite junior race walkers. The purpose of this study was to examine the technique of elite junior race walkers competing at the 8th European Cup Race Walking. Both the junior men's and junior women's races were videoed with two cameras placed at the side of the course where the athletes passed on every lap. Analyses of 20 competitors in each race show that stride length and stride frequency were greater in the fastest groups of athletes. Stride length differences between left-to-right and right-to-left

strides were noticeable in several athletes and these imbalances should be rectified to improve walking efficiency and reduce risk of injury. Flight times were short in most athletes and slower athletes displayed no loss of contact. Athletes were also capable of maintaining straight knees from contact to the vertical upright position. However, many athletes appeared inefficient in rotational motions, with poor pelvic rotation and ungainly arm movements. Junior athletes should spend time developing their technique in order to improve efficiency, reduce the risk of injury, and lessen the chance of disqualification. Training programs to develop both muscular power and endurance are recommended to prepare junior athletes for the demands of senior-level competition.

Hanley, Brian and Bissas, Athanassios (2012) conducted a study on biomechanical analysis of leg asymmetry in young international race walkers. The purpose of this study was to measure kinetic and kinematic variables as well as muscular activity in young international race walkers to observe any possible leg asymmetry. Five men and three women races walked on an instrumented treadmill for 3km and kinetic and kinematic data were collected at the halfway distance. The activity of four muscles on each leg was simultaneously measured using electromyography. Similar to previous findings of elite junior race walkers in competition, half of the athletes had stride length differences, but imbalances in other variables were less common. In particular, vertical ground reaction force peaks were very similar between legs. However, the electromyography findings showed that some of the athletes had substantial differences between leg muscles with regard to activation levels, and that compensation occurred between synergist muscles (gluteus maximus and biceps femoris) within the same leg. Coaches are advised to closely monitor the technical and strength development of their young athletes to ensure that both sides of the body are balanced. This is especially important with

regard to preventing injury, maximizing efficiency, and reducing the risk of disqualification.

Caporaso, Teodorico et al (2020) investigated biomechanical indices represented on radar charts for assessment of performance and infringements in elite race walkers. Nowadays, technology in sports plays an important role to help training and judgement processes. This study proposes the use of a wearable inertial system to derive novel biomechanical indices for the assessment of performance and infringements in race-walking. These indices are built from five inertial-based parameters: loss of ground contact time, loss of ground contact step classification, step length ratio, step cadence, and smoothness. The biomechanical indices are customized for elite racewalkers and represented on a radar chart for intuitive analysis of performance and infringements. From the radar chart, a synthetic index regarding the athlete's overall gesture is derived. The validation of the biomechanical indices is carried out in field tests, involving nine elite race-walkers wearing an inertial sensor located at the end of the column vertebra (L5–S1). A statistical analysis is used to determine the quality and reliability of the proposed indices and their representation. The results show that these biomechanical indices can be implemented on a wearable inertial system for assistance in training and judgement in race-walking.

Hanley, Brian et al (2017) investigated group and age differences in hip muscle activity patterns in elite race walkers. Race walking is a complex activity that relies on considerable power generation by the muscles at the hip joint. Little is known, however, whether differences are present in terms of muscle activity patterns between men and women, or between younger and older athletes. The purpose of this study was to compare hip muscle activity patterns in elite male and female race walkers across U20 and senior age groups. Ten male and ten female race walkers

participated, with five U20 and five senior athletes of each gender. The athletes were recorded using high-speed videography (100 Hz) as they race walked down a 40 m runway, during which the muscle activity of the gluteus medius, gluteus maximus, biceps femoris, and rectus femoris was recorded using electromyography (EMG) (1000 Hz). The hip sagittal angle was calculated from digitised data, and average rectified EMG used to identify visual differences between groups. No differences were found using ANOVA between any groups for the activity of any of the four muscles analysed at toe-off, midswing, heel-strike, and midstance, although there were visual differences in activity timings. Overall, the few differences between groups showed that race walking techniques are comparable across trained athletes and coaches can adopt similar training practices when developing the muscular qualities of their athletes.

Hanley, Brian et al (2015) investigated the technical characteristics of elite junior and woman race walkers. Successful coaching in race walking requires a thorough understanding of the biomechanical principles underlying this unique form of gait. The purpose of this study was to analyze elite male and female junior race walkers and identify key kinematic variables. Twenty junior men and 20 junior women were videoed as they competed over 10 km in the 8th European Cup Race Walking. Three-dimensional kinematic data were obtained using motion analysis software (SIMI, Munich). Step length and cadence were correlated with the speed in both sexes, and greater step lengths were the kinematic reason for junior men's faster walking speeds. While cadence did not differ between junior men and junior women, there was a difference in the proportion of step time spent in contact. There were some differences between genders for upper body joint angles (e.g., elbow) but there were few differences within lower limb joint angles. Although some technical aspects (e.g., pelvic and shoulder girdle rotation) appeared undeveloped, it was noteworthy that most athletes achieved full knee extension at initial contact in accordance with

the rules. However, in many athlete's flight times were evident that might present problems during the transition to the higher standards of senior competition. There was a large range of ability among both sexes and coaches are advised to ensure that technical development continues during the transition to senior competition.

CHAPTER III
METHODOLOGY

SELECTION OF SUBJECTS

For the study, a total of 20 Race Walkers of 20 km events will be selected as the subjects.

The inclusion criteria for the subjects will be:

i. Race walkers who participated at the National and international levels will be considered for the study.

ii. Race walkers, who are free from injuries or muscular disorders will be included in the study.

SELECTION OF VARIABLES

Following angular kinematics variables will be selected for the study:

- Right & left elbow joint
- Right & left shoulder joint
- Right and left hip joint

- Right & left knee joint
- Right & left ankle joint

The following linear kinematic variables will be selected for the study:

- Stride length
- Cadence
- Stance phase duration
- Average Speed
- Symmetry Index
- Height of Center of Mass at single support phase, double support phase, and swing phase
- Time taken for one stride

CRITERION MEASURE

1. Angles will be measured in Degree.
2. Average speed will be measured in m/s.
3. The height of the Center of masses will be measured in cm.
4. Race walking performance will be measured in minutes.
5. Stride length will be measured in cm.
6. Cadence will be measured in steps per minute.
7. Stance phase duration will be measured in seconds.
8. Symmetry Index
9. Time taken for one stride will be measured in seconds.

RESEARCH DESIGN

For the purpose of the study, the Cross-sectional Research design will be used.

ADMINISTRATION OF TEST AND COLLECTION OF DATA

Filming protocol

The race-walking technique will be recorded by following the guidelines of the 2D video recording procedure. Recorded videography will be used in the study for analyzing the selected kinematics variables through Kinovea software 0.8.27.

G-sensor

- To obtain reliable and repeatable data during the execution of the tests, it is necessary to properly position the sensor on the subject to be evaluated.
- For the "Walking Test" protocol the sensor must be positioned below the line that connects the two dimples of Venus – lumbosacral passage, which corresponds to S1-S2 vertebrae.
- Insert the sensor inside the belt, with the flat part facing towards the back of the pocket, and center it on the point of the column that has been previously identified.
- It is recommended to firmly tighten the belt to make it as supportive as possible for the body and to avoid it moving during the execution of the test.

STATISTICAL TECHNIQUE

For analyzing the data of the study, **descriptive statistics** will be used to develop a descriptive profile of each racewalker. **Pearson's correlation** will be used to find the relationship between selected biomechanical variables with race walking performance. An **Independent T-test** will be used to compare the selected biomechanical parameters of national and international race walkers of 20 km. **Multiple Regression Analysis** will be used to predict the race-walking performance based on selected biomechanical variables. The level of significance will be set at 0.05. The statistical analysis will be done with the help of SPSS.

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